

Department of the Interior  
U.S. Geological Survey

**LANDSAT 8 (L8)  
FULL RESOLUTION BROWSE (FRB)  
DATA FORMAT CONTROL BOOK (DFCB)**

**Version 4.0**

**September 2013**



**LANDSAT 8 (L8)  
FULL RESOLUTION BROWSE (FRB)  
DATA FORMAT CONTROL BOOK (DFCB)**

**September 2013**

**EROS  
Sioux Falls, South Dakota**

## **Executive Summary**

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Landsat 8 (L8) is a remote sensing mission, which provides data continuity to the Landsat satellite series global multispectral data collection and distribution. Landsat 8 is a satellite and ground based capabilities collection that provides the following:

- Global, moderate-resolution, multispectral data collection
- Long-term Landsat 8 data archiving
- Web-enabled access
- Continued Landsat International Cooperators (ICs) support
- Level 0 and Level 1 data products

This Full Resolution Browse (FRB), also known as LandsatLook, Data Format Control Book (DFCB) describes the general algorithm for generating browse images, the file formats used for delivery, and the compression methods used.

## **Document History**

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<b>Document Number</b>	<b>Document Version</b>	<b>Publication Date</b>	<b>Change Number</b>
LDCM-DFCB-007	Version 1.0	February 2010	CCR# 117
LDCM-DFCB-007	Version 2.0	April 2011	CCR# 556
LDCM-DFCB-007	Version 3.0	January 2012	DCR# 627
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# **Section 1 Introduction**

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## **1.1 Purpose**

This Data Format Control Book (DFCB) describes the detailed format of the Landsat 8 (L8) browse imagery. The definition of a browse image has changed greatly since the Earth Resources Observation and Science (EROS) Center first started to produce imagery. Early browse images were solely defined by two criteria: 1) their small file size and 2) their ability to permit a user to visually recognize the area covered and to assess overall image cloud cover. With the growth of Google™ Earth and other Web mapping applications, the original intent of browse has evolved from use as a tool for image selection to a visual entity that can also serve for mapping and interpretation.

Landsat 8 browse images are created for quick and efficient image selection and for visual interpretation. The following three criteria are critical to meet user needs for Landsat 8 browse images:

- Provide a “small” browse definition for quick delivery, particularly for large areas
- Provide full spatial resolution browse for local area evaluation
- Provide browse that is geo-registered and GIS-ready

## **1.2 Scope**

This document describes the general algorithm for generating browse images, the file formats used for delivery, and the compression methods used.

## **1.3 Document Organization**

This document contains the following sections:

- Section 1 contains an introduction.
- Section 2 describes the generation of browse images from the Landsat Level 1 product.
- Section 3 describes the file formats used for browse delivery.
- Section 4 describes the compression methods used for browse delivery.
- Section 5 describes the use of the Open Geospatial Consortium (OGC) Web Mapping Service (WMS) for browse delivery.
- Appendix A provides a sample of the GetCapabilities Output file.
- The References section contains a list of reference documents.

## **Section 2 Browse Generation**

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### **2.1 Assumptions**

Level 1 Product Generation System (LPGS) generates browse images from the Level 1 product. The browse generation assumes the following about the Level 1 product:

- The reflective Operational Land Imager (OLI) bands are 30-meter resolution and are stored as 16-bit signed integers that can be linearly scaled to the top of atmosphere reflectance.
- The Thermal Infrared Scanner (TIRS) bands are resampled to 30-meter resolution and are stored as 16-bit signed integers that can be linearly scaled to the top of the atmosphere brightness temperature.
- The LPGS generates a 16-bit Quality Band (QB) (pixel level metadata) as part of the Level 1 product.

Up to five browse files may be associated with each scene:

- OLI Full Resolution Browse (FRB): Three bands, 8-bits per band; referred to as the LandsatLook natural color image.
- OLI Reduced Resolution Browse (RRB): A reduced resolution version of the FRB.
- TIRS FRB: One band, 8-bit grayscale; referred to as the LandsatLook thermal image.
- TIRS RRB: A reduced resolution version of the FRB.
- QB FRB: An 8-bit version of the 16-bit QB associated with the Level 1 product.

### **2.2 Method**

The OLI browse (or LandsatLook natural color) image is generated by extracting three bands from the Level 1 product: band 6 (1610 nm), band 5 (865 nm), and band 4 (655 nm) for the red, green, and blue components of the browse, respectively. These bands correspond to bands 5, 4, and 3 used for the Landsat Enhanced Thematic Mapper Plus (ETM+) browse. The browse data retains full spatial resolution (30 meters) and retains the map projection of the source data (normally polar stereographic for Antarctic scenes and Universal Transverse Mercator (UTM) elsewhere). Radiometrically, each band is scaled to 8-bits per pixel with a gamma stretch:

$$DN_B = 255 * P_p^{(1/\text{gamma})}$$

where  $P_p$  is the top of atmosphere reflectance and  $\text{gamma} = 2.0$ . The three bands are then combined to generate a 24-bit color image, which is Joint Photographic Experts Group (JPEG) compressed with a quality of 75 percent. This JPEG image is both the source data for the WMS service (see Table 2-1) and available for direct download as the “full resolution browse”. This file is typically about six megabytes in size, although the exact size varies depending on the compression.

The TIRS browse (or LandsatLook Thermal image) is generated by extracting the 10.8 um band from the Level 1 product and scaling to an 8-bit grayscale image with a linear stretch, clipping the top and bottom two percent. The browse data retains full spatial resolution (30 meters) and retains the map projection of the source data (normally polar stereographic for Antarctic scenes and UTM elsewhere). The resulting image is JPEG compressed with a quality of 75 percent. This JPEG image is both the source data for the WMS service and available for direct download as the “full resolution browse”. This file is typically about seven megabytes in size, although the exact size varies depending on the compression.

Two additional JPEG images are generated from the full resolution OLI and TIRS browse by scaling the width to 1024 pixels and the height to preserve the original aspect ratio. The scaling is performed with the gdal\_translate utility, using the –outsize option. These images are copied to the Earth Explorer browse directory for use as a “quick look” image, similar to the previous browse images of Landsat 1–7. The OLI file is approximately 250 kilobytes in size while the TIRS file is approximately 89 kilobytes in size.

The 8-bit QB is generated from the 16-bit QB in the Level 1 product by extracting a subset of the bit fields. Table 2-1 displays the exact layout of the bit fields.

	<b>16-Bit Quality (QA) Band</b>	<b>8-Bit Quality (QA) Band</b>		
<b>Bit</b>	<b>Description</b>	<b>Bit</b>	<b>Description</b>	<b>Color</b>
0	Designated Fill	0	Designated Fill	
1	Dropped Frame	1	Dropped Frame	
2	Terrain Occlusion	2	Terrain Occlusion	
3	Reserved	3	Water*	
4	Water Confidence	4	Vegetation*	
5		5	Snow/Ice*	
6	Reserved for cloud shadow	6	Cirrus*	
7		7	Cloud*	
8	Vegetation Confidence	*Set for highest confidence value (11)		
9				
10	Snow/Ice Confidence			
11				
12	Cirrus Confidence			
13				
14	Cloud Confidence			
15				

**Table 2-1. Layout of the Bit Fields**

The confidence levels are as follows:

- 00 = None or Unset
- 01 = 0–33 percent confidence

- 10 = 34–66 percent confidence
- 11 = 67–100 percent confidence

The browse images and 8-bit QB are generated using the Geospatial Data Abstraction Library (GDAL) toolkit.

## **Section 3 File Formats**

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The browse delivery format for the OLI and TIRS (both full and reduced resolution) is the JPEG File Interchange Format (JFIF), version 1.01. The file name consists of the following:

OLI browse = <Landsat\_Scene\_ID> followed by a “.jpg” extension. For example:  
LC80380292009269XXX00.jpg.

TIRS browse = <Landsat\_Scene\_ID>\_TIRS followed by a “.jpg” extension. For example: LC80380292009269XXX00\_TIRS.jpg.

The browse delivery format for the QB is a color mapped Portable Network Graphic (PNG). The file name consists of the following:

QB browse = <Landsat\_Scene\_ID>\_QB followed by a “.png” extension. For example:  
LC80380292009269XXX00\_QB.png.

The format of the Landsat 8 Landsat Scene Identifier is as follows:

L LXSPPPRRYYYYDDDGSIVV

Where:

L = Landsat

X = Sensor (O = OLI only, T = TIRS only , C = OLI andTIRS)

S = Satellite

PPP = WRS Path

RRR = WRS Row

YYYY = Year of Acquisition

DDD = Day of Acquisition Year

GSI = Ground Station Identifier

VV = Version

A world file is generated with each browse image and stored in the same directory. The file name is the same as the browse image, with the .jpg extension replaced by .wld.

The world file is a plain text file with six lines:

1. Pixel size in the x-direction, in map units (normally meters)
2. Rotation about the y-axis (normally zero)
3. Rotation about the x-axis (normally zero)
4. Pixel size in the y-direction, in map units (normally meters)
5. x-coordinate of the center of the upper left pixel
6. y-coordinate of the center of the upper left pixel

Figure 3-1 is an example of a world file. The pixel size in the y-direction is always negative and the sizes are normally 30 meters.

```
30.0000000000
0.0000000000
0.0000000000
-30.0000000000
411014.9999999999
5048985.0000000000
```

**Figure 3-1. Example World File**

In addition, an auxiliary metadata file is generated and stored in the same directory. The file name is the same as the browse image with .aux.xml appended (for the above example LC80380292009269XXX00.jpg.aux.xml). This auxiliary metadata file contains the coordinate reference system information (spheroid, datum, and map projection) and allows the GDAL software or other GIS software to process the JPEG file in much the same way as they would process a Geographic Tagged Image File Format (GeoTIFF) file. Figure 3-2 is an example auxiliary metadata file.

```

<PAMDataset>
  <SRS>PROJCS["WGS 84 / UTM zone 12N",
    GEOGCS["WGS 84",
      DATUM["WGS_1984",
        SPHEROID["WGS 84", 6378137, 298.257223563,
          AUTHORITY["EPSG", "7030"]],
        AUTHORITY["EPSG", "6326"]],
      PRIMEM["Greenwich", 0,
        UNIT["degree", 0.0174532925199433],
        AUTHORITY["EPSG", "4326"]],
      PROJECTION["Transverse_Mercator",
        PARAMETER["latitude_of_origin", 0],
        PARAMETER["central_meridian", -111],
        PARAMETER["scale_factor", 0.9996],
        PARAMETER["false_easting", 500000],
        PARAMETER["false_northing", 0],
        UNIT["metre", 1,
          AUTHORITY["EPSG", "9001"]],
        AUTHORITY["EPSG", "32612"]]]</SRS>
  <Metadata domain="IMAGE_STRUCTURE">
    <MDI key="SOURCE_COLOR_SPACE">YCbCr</MDI>
    <MDI key="INTERLEAVE">PIXEL</MDI>
    <MDI key="COMPRESSION">JPEG</MDI>
  </Metadata>
  <Metadata>
    <MDI key="AREA_OR_POINT">Area</MDI>
  </Metadata>
  <PAMRasterBand band="1">
    <Metadata domain="IMAGE_STRUCTURE">
      <MDI key="COMPRESSION">JPEG</MDI>
    </Metadata>
  </PAMRasterBand>
  <PAMRasterBand band="2">
    <Metadata domain="IMAGE_STRUCTURE">
      <MDI key="COMPRESSION">JPEG</MDI>
    </Metadata>
  </PAMRasterBand>
  <PAMRasterBand band="3">
    <Metadata domain="IMAGE_STRUCTURE">
      <MDI key="COMPRESSION">JPEG</MDI>
    </Metadata>
  </PAMRasterBand>
</PAMDataset>

```

**Figure 3-2. Example Auxiliary Metadata File**

The OLI and TIRS full resolution and QB browse are distributed as a zip file containing the JPEG files, the png file, the world files, and the auxiliary metadata files. Info-ZIP creates the zip file. An example list of the zip file is shown as follows:

Archive: LC80390362003148EDC00.zip

Length	Date	Time	Name
1201819	05-12-11	11:11	LC80390362003148EDC00.jpg
1443	05-12-11	11:11	LC80390362003148EDC00.jpg.aux.xml
92	05-12-11	11:11	LC80390362003148EDC00.wld
1862641	05-12-11	11:11	LC80390362003148EDC00_TIR.jpg
985	05-12-11	11:11	LC80390362003148EDC00_TIR.jpg.aux.xml
92	05-12-11	11:11	LC80390362003148EDC00_TIR.wld
12432993	05-12-11	11:11	LC80390362003148EDC00_QB.png
13886	05-12-11	11:11	LC80390362003148EDC00_QB.png.aux.xml
92	05-12-11	11:11	LC80390362003148EDC00_QB.wld
-----			-----
15514043			9 files

## **Section 4    Compression**

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The browse images are compressed using the JPEG compression algorithm with a quality of 75 percent. The 8-bit QB PNG uses deflate compression, which is lossless.

## **Section 5 WMS Delivery**

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In addition to the static images, browse is also available as an OGC WMS layer. The base Uniform Resource Locator (URL) of the WMS is [http://earthexplorer.usgs.gov/cgi-bin/landsat\\_8](http://earthexplorer.usgs.gov/cgi-bin/landsat_8). Each scene is a layer named by the scene ID. The WMS GetCapabilities request can return detailed information about each layer (see Appendix A). The general configuration is as follows:

- Version 1.1.1 of the WMS specification
- Supported map projections:
  - Geographic (latitude / longitude) (EPSG 4326)
  - “Spherical Mercator” (EPSG 3857), used by many popular Web mapping applications
  - UTM (zone of center point plus one zone east and west), except for Antarctic scenes
  - Polar stereographic (EPSG 3031), for Antarctic scenes only
- Supported formats:
  - JPEG
  - PNG
  - GeoTIFF

## Appendix A Sample GetCapabilities Output

---

```
<?xml version='1.0' encoding="ISO-8859-1" standalone="no" ?>
<!DOCTYPE WMT_MS_Capabilities SYSTEM
"http://schemas.opengis.net/wms/1.1.1/WMS_MS_Capabilities.dtd"
[
<!ELEMENT VendorSpecificCapabilities EMPTY>
]> <!-- end of DOCTYPE declaration -->

<WMT_MS_Capabilities version="1.1.1">

<Service>
  <Name>OGC:WMS</Name>
  <Title>Landsat WMS server</Title>
  <Abstract>Landsat WMS server</Abstract>
    <KeywordList>
      <Keyword>Landsat</Keyword>
    </KeywordList>
  <OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?" />
  <ContactInformation>
  </ContactInformation>
  <Fees>none</Fees>
  <AccessConstraints>none</AccessConstraints>
</Service>

<Capability>
  <Request>
    <GetCapabilities>
      <Format>application/vnd.ogc.wms_xml</Format>
      <DCPType>
        <HTTP>
          <Get><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?" /></Get>
          <Post><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?" /></Post>
        </HTTP>
      </DCPType>
    </GetCapabilities>
    <GetMap>
      <Format>image/png</Format>
      <Format>image/tiff</Format>
      <Format>application/x-nitf</Format>
      <Format>image/gif</Format>
      <Format>image/png; mode=24bit</Format>
      <Format>image/jpeg</Format>
      <Format>image/vnd.wap.wbmp</Format>
      <Format>image/svg+xml</Format>
      <DCPType>
        <HTTP>
          <Get><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?" /></Get>
          <Post><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?" /></Post>
        </HTTP>
      </DCPType>
    </GetMap>
  </Request>
</Capability>
```

```

    </GetMap>
<GetFeatureInfo>
    <Format>text/plain</Format>
    <Format>text/html</Format>
    <Format>application/vnd.ogc.gml</Format>
    <DCPType>
        <HTTP>
            <Get><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?" /></Get>
            <Post><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?" /></Post>
        </HTTP>
    </DCPType>
</GetFeatureInfo>
<DescribeLayer>
    <Format>text/xml</Format>
    <DCPType>
        <HTTP>
            <Get><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?" /></Get>
            <Post><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?" /></Post>
        </HTTP>
    </DCPType>
</DescribeLayer>
<GetLegendGraphic>
    <Format>image/png</Format>
    <Format>image/gif</Format>
    <Format>image/png; mode=24bit</Format>
    <Format>image/jpeg</Format>
    <Format>image/vnd.wap.wbmp</Format>
    <DCPType>
        <HTTP>
            <Get><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?" /></Get>
            <Post><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?" /></Post>
        </HTTP>
    </DCPType>
</GetLegendGraphic>
<GetStyles>
    <Format>text/xml</Format>
    <DCPType>
        <HTTP>
            <Get><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?" /></Get>
            <Post><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?" /></Post>
        </HTTP>
    </DCPType>
</GetStyles>
</Request>
<Exception>
    <Format>application/vnd.ogc.se_xml</Format>
    <Format>application/vnd.ogc.se_inimage</Format>
    <Format>application/vnd.ogc.se_blank</Format>
</Exception>

```

```

<VendorSpecificCapabilities />
<UserDefinedSymbolization SupportSLD="1" UserLayer="0" UserStyle="1"
RemoteWFS="0"/>
<Layer>
  <Name>Landsat_8</Name>
  <Title>Landsat WMS server</Title>
  <Abstract>Landsat WMS server</Abstract>
  <KeywordList>
    <Keyword>Landsat</Keyword>
  </KeywordList>
  <SRS>EPSG:4326</SRS>
  <LatLonBoundingBox minx="-180" miny="-90" maxx="180" maxy="90" />
<Layer>
  <Name>L1GTtir</Name>
  <Title>L1GTtir</Title>
  <Abstract>L1GTtir</Abstract>
  <Layer queryable="0" opaque="0" cascaded="0">
    <Name>LC80390362000140EDC00_TIR</Name>
    <Title>LC80390362000140EDC00_TIR</Title>
    <SRS>EPSG:32611</SRS>
    <SRS>EPSG:32610</SRS>
    <SRS>EPSG:32612</SRS>
    <SRS>EPSG:4326</SRS>
    <SRS>EPSG:3857</SRS>
    <SRS>EPSG:900913</SRS>
    <LatLonBoundingBox minx="-116.494" miny="33.6174" maxx="-113.999"
maxy="35.6235" />
  </Layer>
  <Layer queryable="0" opaque="0" cascaded="0">
    <Name>LC80390362000076EDC00_TIR</Name>
    <Title>LC80390362000076EDC00_TIR</Title>
    <SRS>EPSG:32611</SRS>
    <SRS>EPSG:32610</SRS>
    <SRS>EPSG:32612</SRS>
    <SRS>EPSG:4326</SRS>
    <SRS>EPSG:3857</SRS>
    <SRS>EPSG:900913</SRS>
    <LatLonBoundingBox minx="-116.485" miny="33.6171" maxx="-113.986"
maxy="35.6235" />
  </Layer>
</Layer>
<Layer>
  <Name>L1GTref</Name>
  <Title>L1GTref</Title>
  <Abstract>L1GTref</Abstract>
  <Layer queryable="0" opaque="0" cascaded="0">
    <Name>LC80390362000076EDC00</Name>
    <Title>LC80390362000076EDC00</Title>
    <SRS>EPSG:32611</SRS>
    <SRS>EPSG:32610</SRS>
    <SRS>EPSG:32612</SRS>
    <SRS>EPSG:4326</SRS>
    <SRS>EPSG:3857</SRS>
    <SRS>EPSG:900913</SRS>
    <LatLonBoundingBox minx="-116.485" miny="33.6171" maxx="-113.986"
maxy="35.6235" />
  </Layer>
</Layer>

```

```
<Layer queryable="0" opaque="0" cascaded="0">
  <Name>LC80390362000140EDC00</Name>
  <Title>LC80390362000140EDC00</Title>
  <SRS>EPSG:32611</SRS>
  <SRS>EPSG:32610</SRS>
  <SRS>EPSG:32612</SRS>
  <SRS>EPSG:4326</SRS>
  <SRS>EPSG:3857</SRS>
  <SRS>EPSG:900913</SRS>
  <LatLonBoundingBox minx="-116.494" miny="33.6174" maxx="-113.999"
maxy="35.6235" />
</Layer>
</Layer>
</Layer>
</Capability>
</WMT_MS_Capabilities>
```

## References

---

Please see [http://landsat.usgs.gov/tools\\_acronyms\\_ALL.php](http://landsat.usgs.gov/tools_acronyms_ALL.php) for a list of acronyms.

GeoTIFF Format Specification, GeoTIFF Revision 1.0, Specification Version 1.8.2. 28 December 2000. <<http://www.remotesensing.org/geotiff/spec/geotiffhome.html>>

JPEG File Interchange Format, Version 1.02.  
<<http://www.w3.org/Graphics/JPEG/jfif3.pdf>>

JPEG Standard (JPEG ISO/IEC 10918-1 ITU-T Recommandation T.81).  
<<http://www.w3.org/Graphics/JPEG/itu-t81.pdf>>

Open GIS Consortium, OGC 01-068r3, Web Map Service Implementation Specification, Version 1.1.1, January 16, 2002.  
<[http://portal.opengeospatial.org/files/?artifact\\_id=1081&version=1&format=pdf](http://portal.opengeospatial.org/files/?artifact_id=1081&version=1&format=pdf)>

Portable Network Graphics (PNG) Specification (Second Edition).  
<<http://www.w3.org/TR/2003/REC-PNG-20031110/>>

World files for raster datasets.  
<[http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?topicname=World\\_files\\_for\\_raster\\_datasets](http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?topicname=World_files_for_raster_datasets)>

Netpbm.  
<<http://netpbm.sourceforge.net/doc/>>

Geospatial Data Abstraction Library (GDAL).  
<<http://www.gdal.org/>>